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UK Undergraduate Research Program

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UK Undergraduate Research Program

The UK Undergraduate Research Program (UKURP) provides undergraduates, especially first- and second-year students, with the opportunity to identify and connect with faculty members who are seeking undergraduates to work with them on their scholarly projects. Projects are available in all disciplines and require varying levels of experience and sophistication. More information is available at www.uky.edu/eureka/ukurp.

Students who are actively engaged in a mentored scholarly research project through UKURP and who are spending an average of approximately 10 hours per week on that project are eligible to register for a research methods course, DSP 200, taught each spring. The final project in the course is for the student to prepare an abstract of his or her research. The following are samples of those abstracts from the spring semester, 2007, class.

A Novel Interaction of cyclic-AMP dependent PKA Regulatory Subunit Type 1-alpha with Cardiac Troponin T

Catherine Bozio

Mentor: Marius Sumandea, Assistant Professor, Department of Internal Medicine

For an abstract of Catherine's research, see her report under Summer Research and Creativity Awards, p.100.

CO_2 Environment: How Bad Could It Be?

Tyler McLaurine

Faculty Mentor: Robin Cooper, Ph.D., Department of Biology

Studies examining carbon dioxide (CO_2) effects on behavior and physiology may give insights into organisms most likely to be strongly affected by toxic CO_2 levels. When an animal remains in a hypoxic (oxygen-deficient) environment, it must compensate for the reduction in the availability of oxygen (O_2). In an environment saturated with carbon dioxide, an oxygen-dependent organism will eventually become hypoxic and unable to survive. Adaptations to hypoxia vary depending on the duration of exposure. Some adaptations seen with a decrease in oxygen are the organism's response of increasing ventilatory rate (VR) and heart rate (HR). These respiratory adaptations are noticeable in crayfish. This study examines whether crayfish experience a known behavioral anesthetic effect seen in insects upon CO_2 exposure.

One foundation for this research is a previous experiment on Drosophila (fruit fly) larvae exposed to carbon dioxide, which become non-responsive to stimuli. To understand this effect in crayfish, their behavioral and physiological states were monitored while they were exposed to an atmosphere saturated with CO_2. By examining external and internal responses, we gained insights into behavioral and cellular mechanisms of carbon dioxide. In this study, heart and ventilatory rates were monitored to correlate to behavioral changes, before, during, and after exposure to CO_2.

We observed a dramatic decrease in heart (HR) and ventilatory (VR) rates, which directly corresponded to CO_2 exposure. HR dropped almost immediately after exposure, which correlated with effects seen in Drosophila larvae. Furthermore, we observed that VR dramatically decreased during exposure, but continued sporadically. Upon reentry into the O_2 environment, VR increased almost immediately and remained higher than the baseline for an extended period of time. This increase in VR most likely occurred in order to compensate for the lack of oxygen experienced by the crayfish during CO_2 exposure. This finding suggests that ventilatory rate may be controlled voluntarily to compensate for hypoxic conditions. However, HR had a much slower transition back to its normal level than VR in oxygenated water. This finding suggests that crayfish HR is inhibited by CO_2 at the molecular level. It is likely that CO_2 molecules block a specific receptor at the heart, which has negative effects on crayfish HR overall. In addition, behavioral observations showed that hypoxic conditions severely affect crayfish movement. The lack of O_2 experienced by crayfish in a CO_2 saturated environment causes an overall decrease in responsiveness. Overall, this study allowed us to better understand the effects of CO_2, as well as compare its effects between different organisms and environments.

My experience with this research has been quite rewarding. I have been able to gain insights into crayfish behavior and physiology through hands-on experience. My research in this field has further inspired me to investigate and understand how various chemical mechanisms affect the behavior and physiology of organisms. I am truly grateful to have had the opportunity to play the primary role in this study under the direction of Sonya Bierbower and Dr. Robin Cooper. I plan to continue and expand on this research next fall.

The Effect of Temperature on Closely Related Organisms

Olivia Ringo

Mentor: Stephen M. Testa, Ph.D., Associate Professor of Chemistry, Biological Chemistry

The *Bacillus*, *Lactobacillus*, and *Streptomyces* genera all have species that grow in three temperature classes: psychrophile, mesophile, and thermophile, which are in order from coldest to hottest temperatures. The organisms selected for study were chosen based on the large number of species that each genus contains, and the fact they all have several organisms that thrive in each of the three temperature classes. I am examining Ribonucleic Acid (RNA) that is synthesized from the adenylate kinase gene, which is found in organisms from each of the three temperature classes. Adenylate Kinase was the gene selected because it has been sequenced across the three temperature classes in the organisms we are studying.

Identifying the nucleotide sequences for the adenylate kinase RNA allows the relative stability of the RNA in each temperature class to be studied. This identification is done by taking the complimentary RNA sequences derived from the DNA sequences that are found in published scientific papers and running them through a program called *RNA structure*. This program produces images of the most stable foldings of the RNA, together with a numerical measure of each folding's stability. The stability is measured as the change in enthalpy (ΔG), expressed as kilocalories/mole, and a more negative number indicates a more stable molecule.

RNA structure calculates the stability under standard free energy parameters at 37° C. Using a complex set of files that determine base pairing, energy of free ends, and multi-branch loop stacking among other things, *RNA structure* is able to produce a theoretical folded molecule with its accompanying stability. By examining the stability of similar RNA across all three temperature classes, I will determine the evolutionary role temperature plays in altering an organism to adapt to a temperature-related environment.

The conclusions drawn thus far are that RNA stability *is* related to temperature. Additionally, the stability increases as expected; because thermophilic organisms grow at higher temperatures and have a greater input of energy to cope with, the RNA must be more stable so that it does not melt apart. Conversely, the psychrohilic RNA must be less stable, otherwise at such low temperatures it would be so compacted that it would not be able to be replicated. Future plans include comparing nucleotide sequence similarities, and attempting to determine which organisms gave rise to the others in their genus.